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DEVELOPMENT AND TESTING OF A RECOVERABLE PROBE (RSP)

By

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SUMMARY

The development and flight-testing of a recoverable, high-altitude probe is described. The air-launched vehicle, designated the Recoverable SPAROAIR Probe (RSP), ascends to an altitude of approximately 150,000 feet carrying a 70mm camera as payload. The camera, contained in a capsule, is recovered from the sea following water impact.

The significant characteristics of the probe are:

1. The aerodynamic design of the recoverable capsule provides orientation of the capsule during camera operation and descent.
2. The aft lid of the capsule is utilized as the deceleration device in lieu of a parachute system.
3. The structural design and payload packaging permits a velocity of 150 feet per second at water impact without damage to the structure or components contained in the capsule.

INTRODUCTION

This report describes one phase of the continuing development of recovery systems at the Naval Missile Center, Point Mugu, California. This phase involved developing and testing two air-launched vertical probes consisting of SPAROAIR vehicles fitted with specially adapted, recoverable nose cones. These vehicles have been designated recoverable SPAROAIR probes (RSP).

One purpose of the development program was to flight-test the aerodynamic configuration and recovery system of the capsule developed for the CARP project and described in reference 1.

The report is divided into three major parts, which describe (1) the overall vehicle and its components, (2) the ground-test and environmental-test programs, and (3) the performance-test program.

The task was undertaken and completed under NMC project LD-2305, Development of Tactical Probes.

DESCRIPTION OF EQUIPMENT

General Description of RSP System

Physical Description

The RSP system consists of an air-launched, two-stage rocket with a recoverable payload capsule mounted as the rocket's nose cone. The two SPARROW III motors in tandem, the ignition system and the fin assembly which this vehicle utilizes are described in reference 2. The capsule is a two-thirds scale CARP capsule, being 12 inches in diameter, and it contains a recovery system together with a rear-looking 70mm camera. The capsule is attached to the front of the second-stage motor by a transition piece containing the capsule-separation device. Figure 1 shows the RSP on the launch aircraft.

Operational Description

Launch

The RSP is launched from an Aero 4A rail launcher mounted on the wing of an F4D aircraft. Launch occurs at an altitude of 32,000 feet and at Mach 0.62, with the launch aircraft at an attitude of 85 degrees above the horizontal. Following launch, the aircraft continues the loop, rolls out at apogee, and proceeds in a direction away from the eventual impact area.

Figure 1. RSP on Launch Aircraft.

Sequence of Operations

The following sequence occurs from time of vehicle launch (t) to its water impact (see figure 2):

t = 0	first-stage ignition second-stage ignition-delay system actuated capsule separation-delay device actuated
t = 1.8 sec	first-stage burnout
t = 20 sec	second-stage ignition first-stage separation
t = 35 to 43 sec (as selected)	capsule separation camera ON C-band chaff ejected barometric switch armed
t = 88 sec	apogee at 145,000 feet
t = 250 sec	barometric switch closed at 20,000 feet rear lid ejected S-band chaff ejected
t = 278 sec	water impact recovery-beacon antenna deployed dye marker deployed

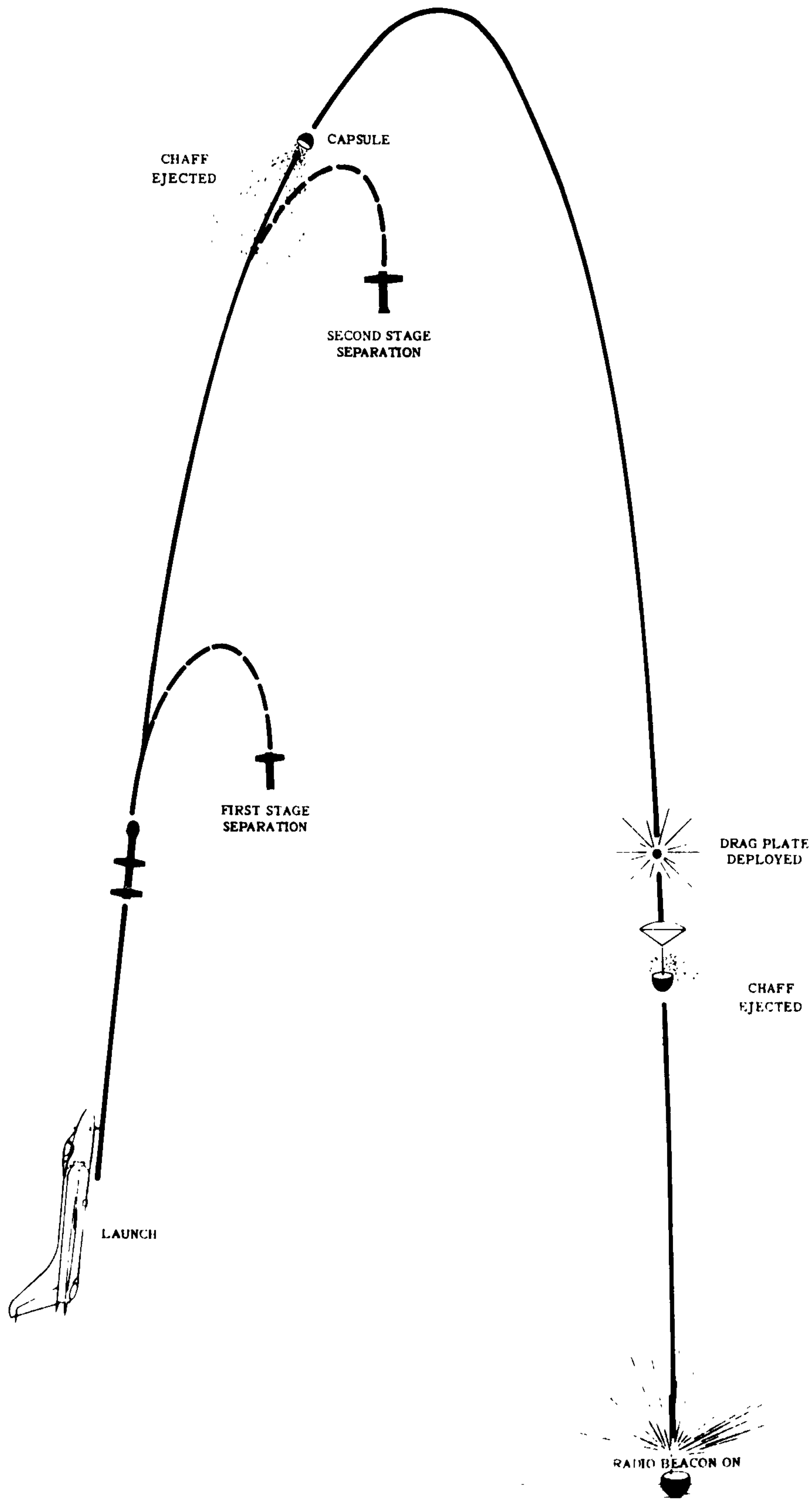


Figure 2. Sequence of Operations.

Flight Profile and Trajectory

The vehicle capsule attains an altitude of 145,000 feet and a maximum ınge of 48,000 feet under the design-launch conditions. Figures 3 through 5 əpict the estimated drag versus Mach number and the altitude and velocity rofiles.

Ↄapsule

Aerodynamic Design

The RSP capsule (figure 6) is a two-thirds scale CARP capsule, as described in reference 1. This configuration has completed wind-tunnel tests at the Naval Missile Center Aerodynamic Test Facility. In summary, the capsule is designed to be aerodynamically stable, at one angle of attack, from subsonic to hypersonic velocities. The high-drag configuration of the capsule provided deceleration at high altitudes, which minimizes aerodynamic heating and results in the relatively low impact velocity of 350 feet per second in the event other design features of the deceleration system fail.

Structure

The capsule is constructed of stainless steel. A hemispherical, 1/16-inch-thick nose cap is welded to the conical section, which is 1/32 inch thick. The thicker nose section provides added protection at water impact.

Heat Shield

The material used for the heat-shield was a sublimating paint-like formulation, THERMO-LAG, proprietary to Emerson Electric Company. This material sublimes at a predesigned temperature, in this instance 500 degrees F, independent of the heat input.

The ablative material was applied directly to the stainless-steel shell of the capsule with standard spray-painting equipment. Following application and curing, the capsules were subjected to handling and storage for a period of 2 months with no sign of deterioration or damage.

Transition Piece With Capsule-Separation Device

Figures 7 and 8 show the transition piece which connects the 12-inch-diameter capsule to the 8-inch-diameter second-stage motor. The transition piece houses the second-stage ignition, described in reference 2, and the capsule-separation device. The 1/16-inch-thick exterior skin of the transition piece is fitted with the umbilical connection to the launcher and the lanyard switches for second-stage ignition and capsule-separation actuation (see figure 9).

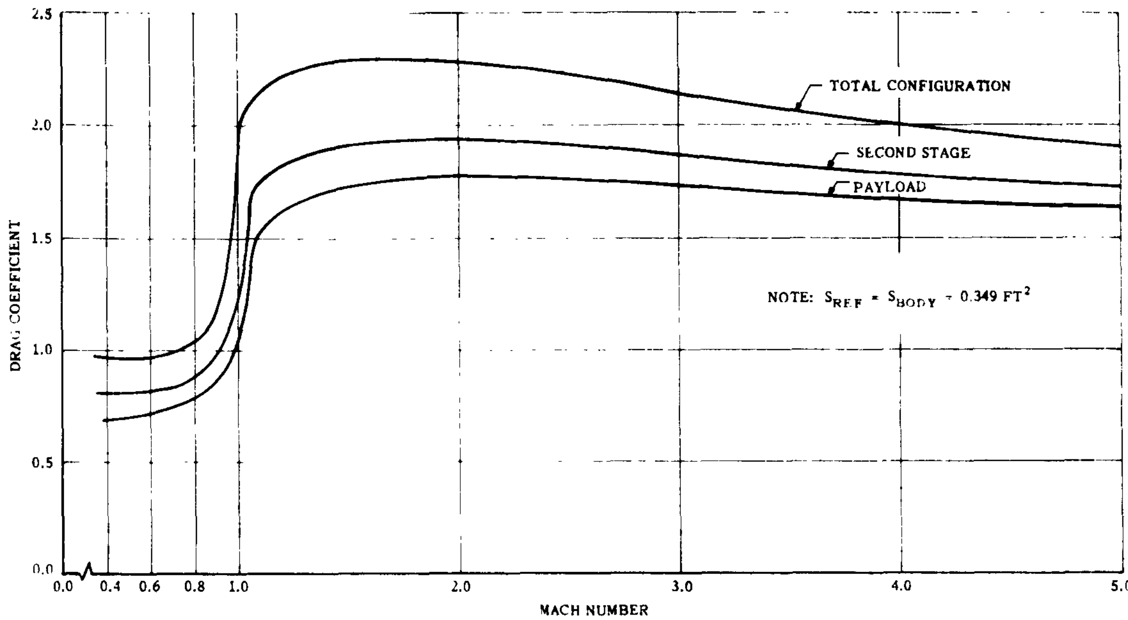


Figure 3. Estimated RSP Drag Coefficient.

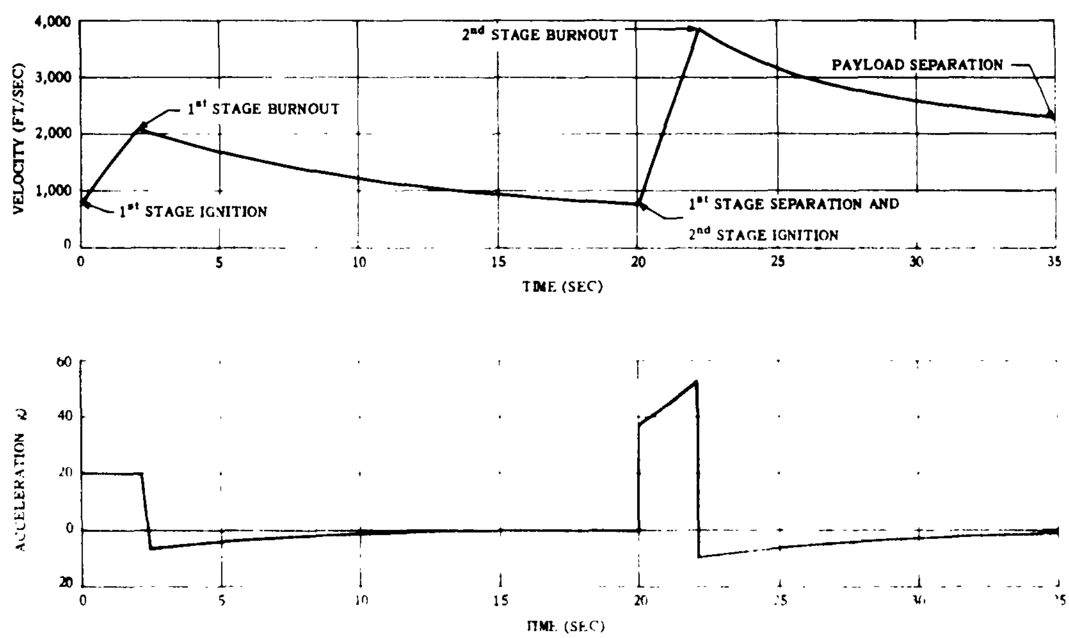


Figure 4. Estimated RSP Velocity Acceleration Versus Time.

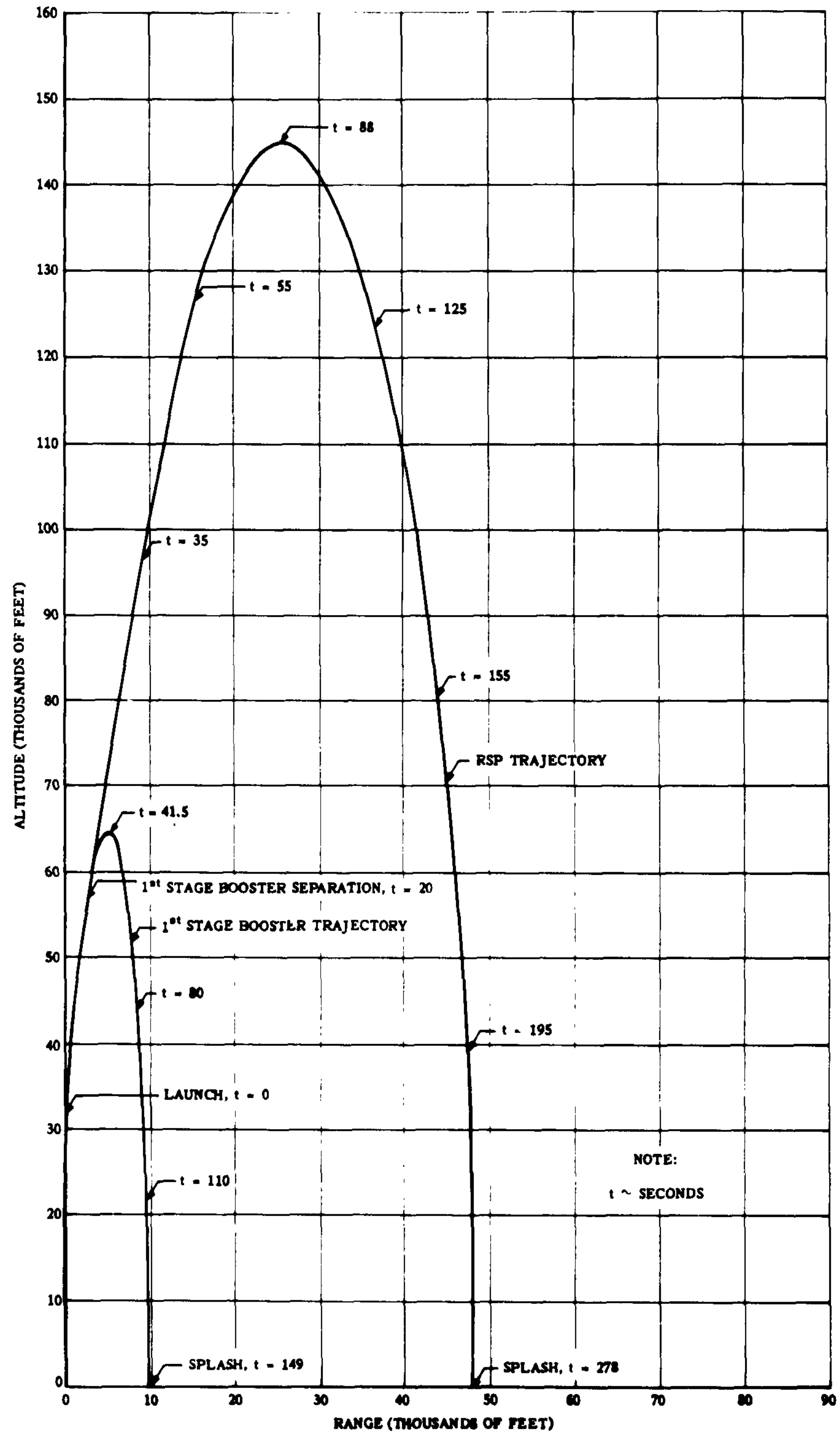


Figure 5. Predicted RSP Nominal Trajectory.

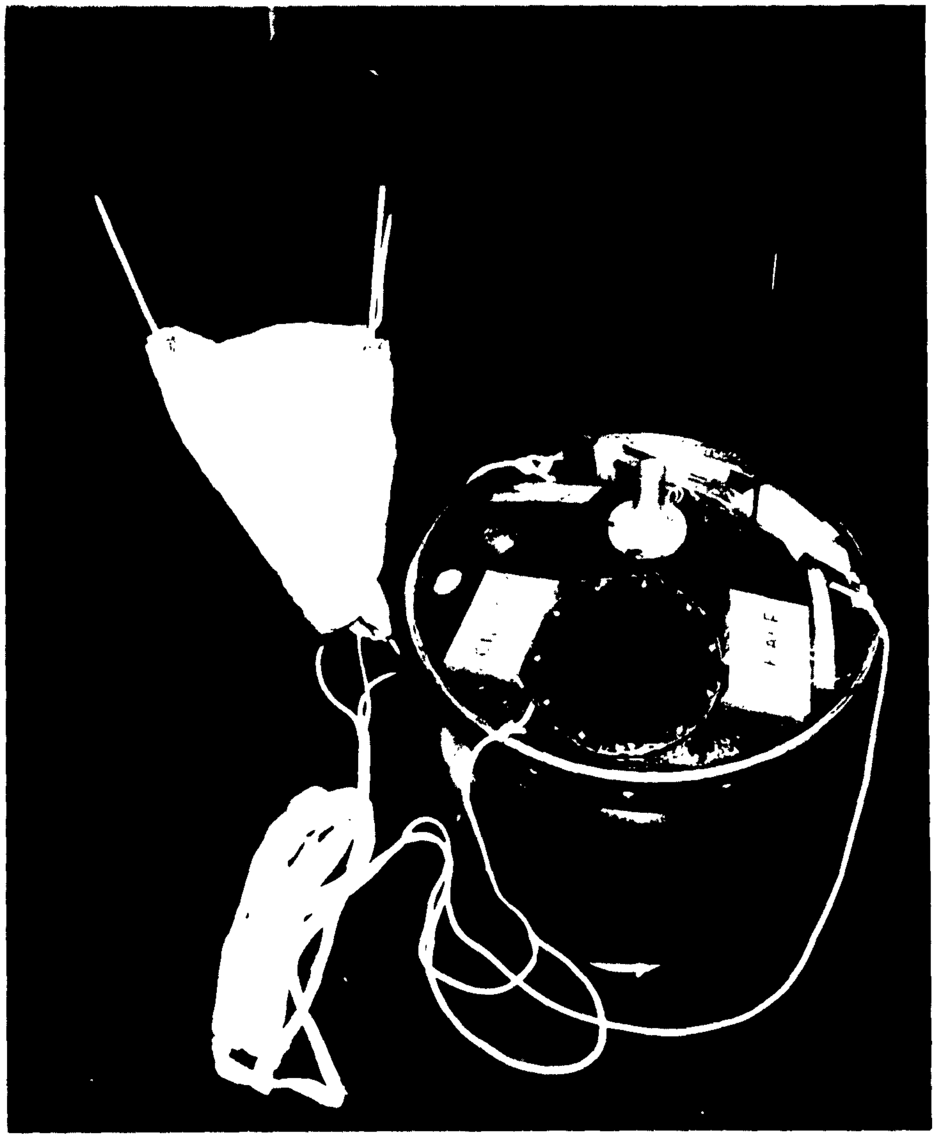


Figure 6. RSP Capsule With Drag Plate.

The major difference between RSP flight-test vehicles No. 1 and No. 2 is the method used to separate the capsule from the second-stage motor. In flight-test vehicle No. 1, separation is caused when an explosive bolt releases the capsule from the motor and a spring provides a separation force of 320 pounds with a travel of 1 inch. In flight-test vehicle No. 2, the separation device utilizes an explosive actuator of 3/4-inch bore and 2-inch stroke to force separation. The explosive force is generated by two DuPont S-68 4-grain squibs. The piston is attached directly to the capsule structure and is attached, in turn, to the transition piece through a 3/16-inch aluminum shear pin. The breech of the piston is provided 1/4-inch free travel, allowing the shear pin to be cut before any significant force is required to separate the capsule (see figure 10). The spring installed in vehicle No. 2 is primarily an aid to assembly.

Figure 7. Motor End of Transition Piece.

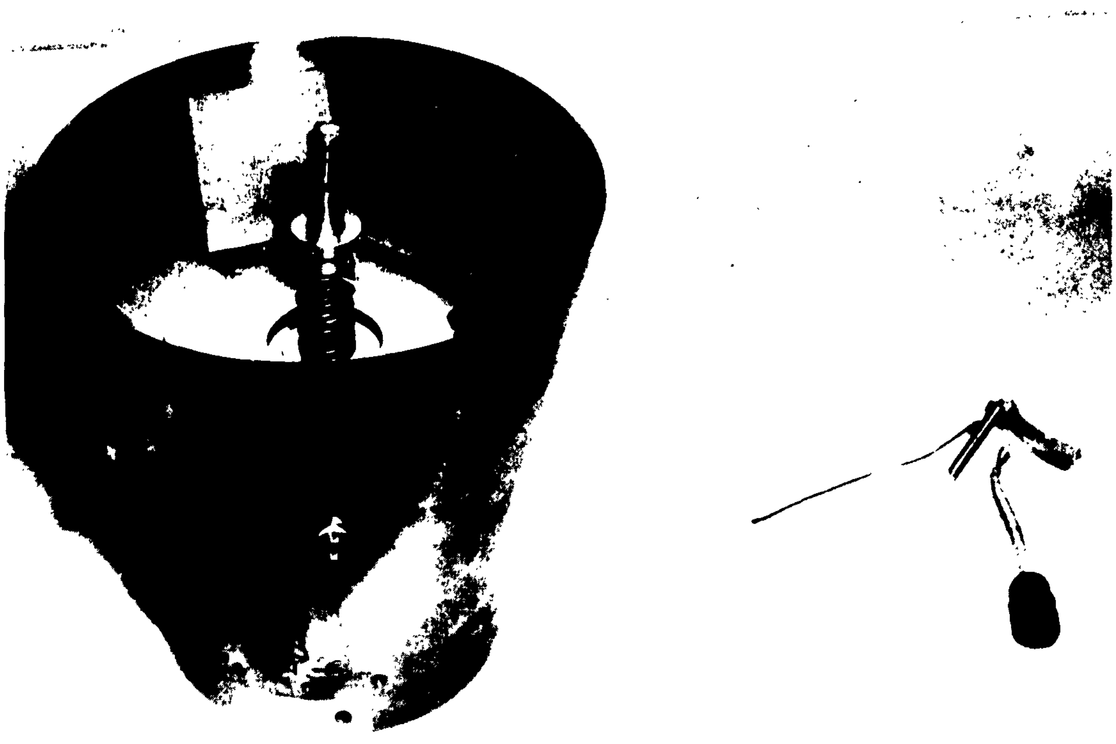


Figure 8. Capsule End of Transition Piece With C-Band Chaff in Place (Vehicle No. 1).

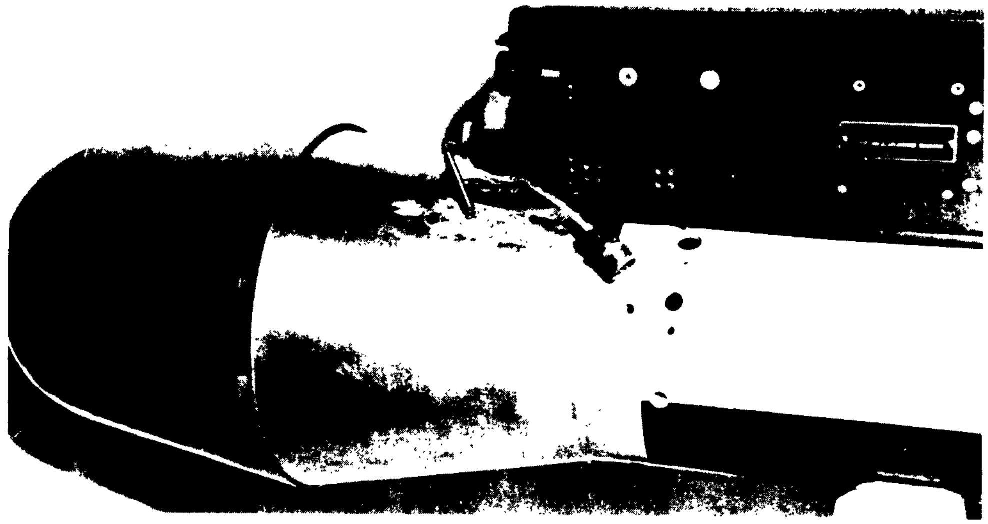


Figure 9. Umbilical Connection.

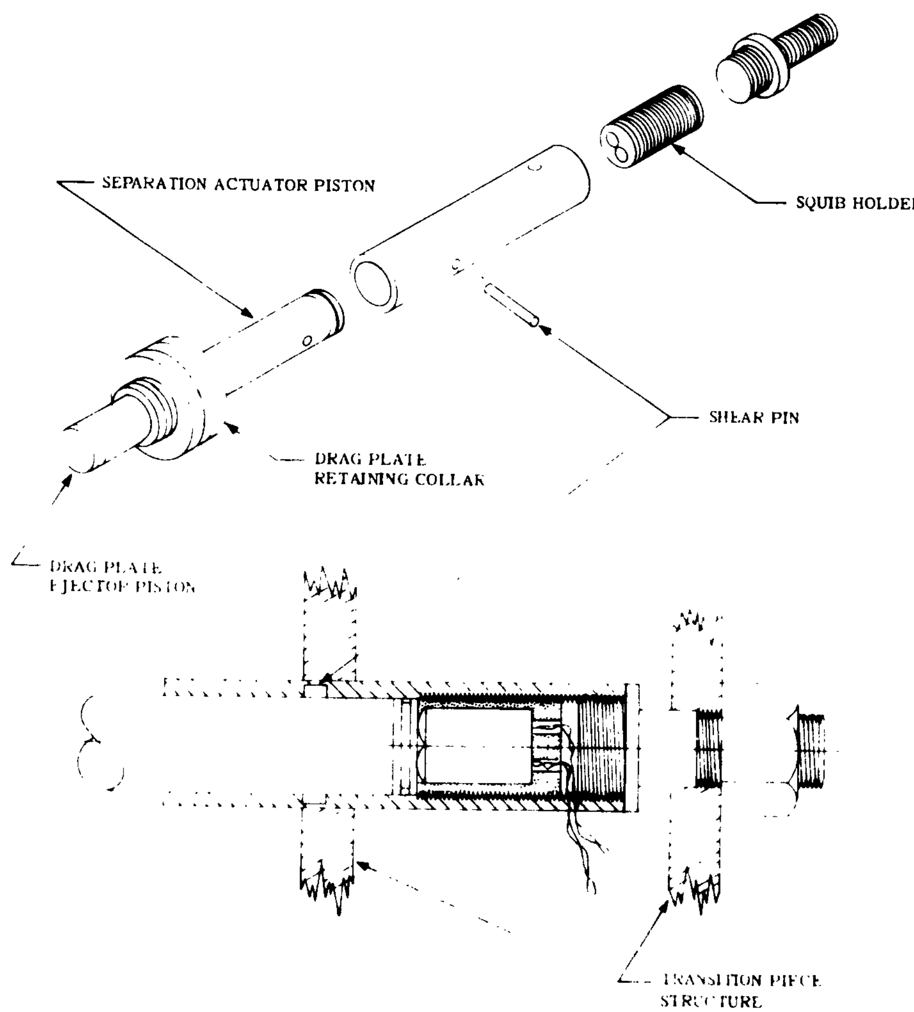


Figure 10. Payload Actuator.

Flotation

During assembly of the capsule, when all of the components have been installed, wired, and checked, the interior of the capsule is filled with self-foaming polyurethane foam. The foam is allowed to rise over the top of the capsule and is then cut to conform to the underside of the drag plate. Cavities are cut into the foam to hold the recovery aids, and its exposed surface is then sealed with epoxy resin to prevent water leakage following impact. The foam not only attenuates the shock applied to the contained components but also provides positive buoyancy for an indefinite period of time. The capsule displaces 37 pounds of water and weighs 31 pounds when fully assembled. The resultant buoyant force is 6 pounds. The underside of the capsule lid is covered with a 1/2-inch-thick layer of foam. To assure a positive bond, the foam is cemented to the lid after forming.

Power Supply

The capsule's power supply consists of 40 nickel-cadmium, 1-ampere-hour cells connected in two separate power packs. The cells are type AVN8Z, manufactured by Nicad Division, Gould-National Batteries, Incorporated. Each cell is 1.140 inches wide, 0.700 inch long, and 2.300 inches high. Each weighs 0.12 pound.

The SARAH recovery-beacon power supply consists of 15 cells connected in series-parallel, providing a potential of 6.5 volts under no load. The recovery beacon is expected to operate for 3 hours.

The camera and ejector-squib power supply consists of 25 cells connected in series. The arming plug on this circuit is deliberately exposed so that the power pack will ground out following water entry. This feature is used to terminate the camera operation.

All batteries were wired, installed, then potted in place with polyurethane foam. Figure 11 shows the batteries in the process of being potted into the capsule. Electrical leads from the battery packs were connected to the checkout plug on the top of the capsule so that the batteries could be charged prior to operation.

Recovery System

Deceleration Device

To reduce weight and complexity of the recovery system, the rear lid of the capsule is utilized as a drag plate in lieu of a recovery parachute. It was calculated that the capsule without the drag plate would impact at a velocity of 350 feet per second. With the added drag introduced by the drag plate, as measured by the drag meter, the impact velocity is limited to 150 feet per second. A test

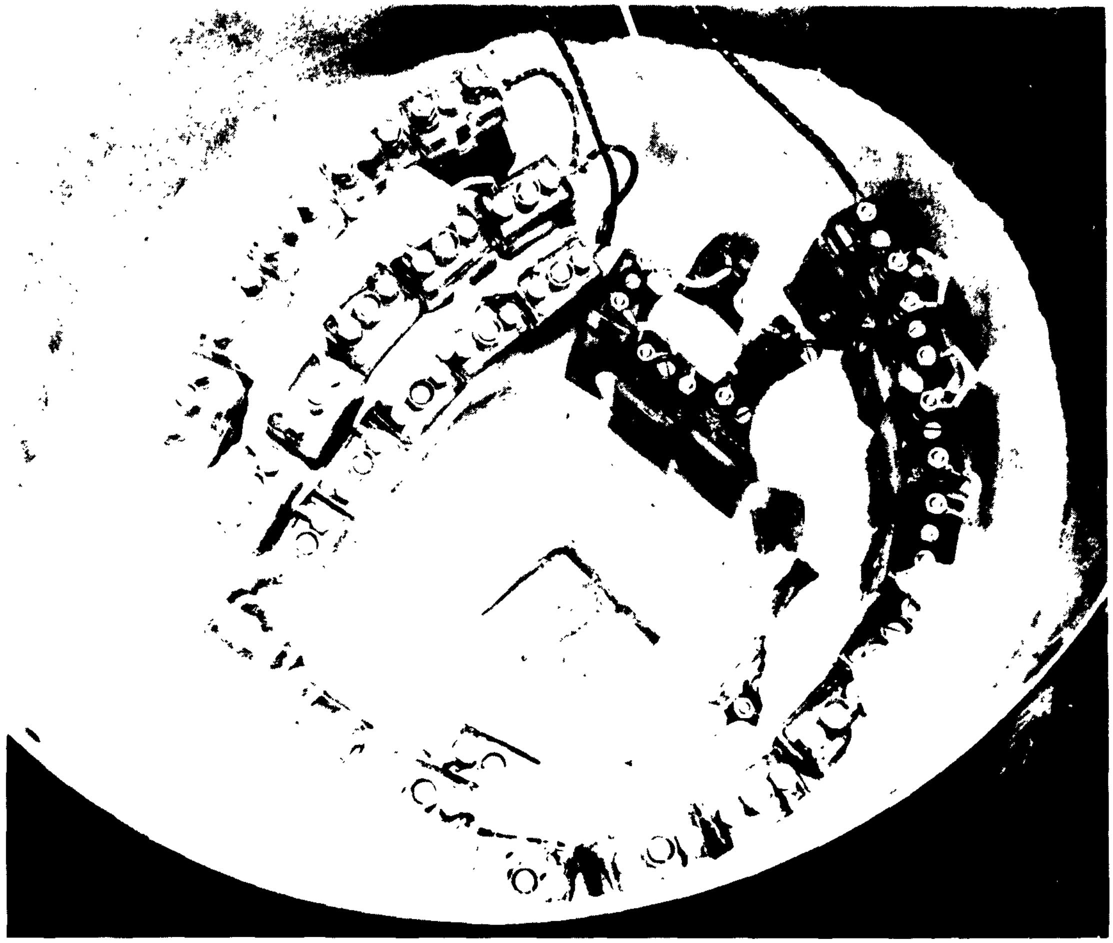


Figure 11. Batteries During Assembly.

series was conducted to determine the acceleration of the capsule at water entry and the results are summarized in table 1.

Ejection Device

The drag plate is attached by a collar to the explosive piston between the capsule and the second-stage motor (see figure 12). A 3/16-inch aluminum shear pin retains the piston in the ejector cylinder. Two 1-grain DuPont S-75 squibs, when fired by the barometric switches, eject the connecting piston and rear lid rearward at a velocity of 34 feet per second.

Barometric Switch

Two barometric switches connected in parallel are used to actuate the drag-plate ejection at an altitude of 20,000 feet during the descent of the capsule. The switches are type 615-4A-46, manufactured by Meletron Corporation. To prevent actuation of the switch during ascent, the switches are calibrated to close

Table 1. Helicopter Drop Test Results

Flight Test No.	Drop Altitude (Ft)	Drag Meter Reading (Lb)	Impact Gage Reading (g)	Impact Velocity (Ft/Sec)	Remarks
1	500	120	Not Used	110	Drag plate extremely unstable. Some damage to nose due to thin section.
2	1,500	100	Not Used	150	A 0.25-inch hole was in center of drag plate.
3	1,500	80	283*	150	Five 0.25-inch holes were drilled in drag plate.
4	2,000	40	449	Unknown	A nylon cone was placed over the drag plate bridle. Very stable descent.
5	4,000	Unknown	Unknown	155	Nylon cone was used and drag plate was stable. The capsule was lost at sea.
6	4,000	Not Used	260	122	Nylon cone was used. Slight instability of drag plate observed.

*The impact gage was installed with approximately 1/4-inch of polyurethane foam between it and the internal nose tip. It is believed that this reading is not accurate.

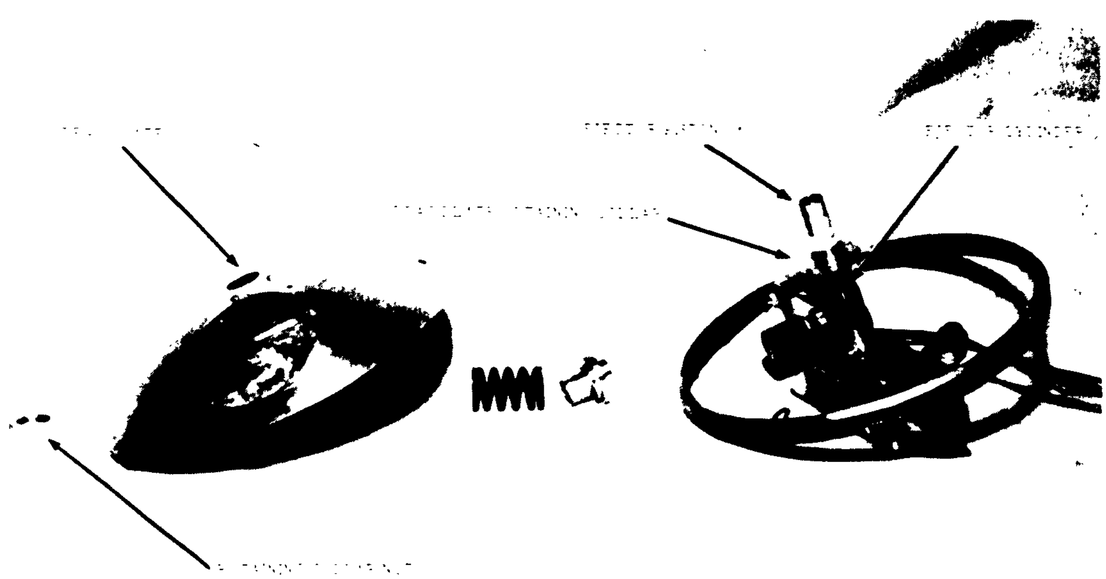


Figure 12. RSP Ejector Mechanism.

at an altitude lower than the launch altitude and are not armed until after launch. Arming is caused by capsule separation, at which time a lanyard between the capsule and transition piece withdraws, releasing a spring-loaded switch which, in turn, closes the circuit. Ports for the barometric switches are located in the vicinity of the radio-beacon antenna under the drag plate. This location prevents the switches from being actuated inadvertently by ram air if the capsule is tumbling during descent.

Search and Locating Aids

SARAH Beacon: A standard SARAH recovery beacon (figure 13), transmitting on a frequency of 235 Mc, is used as the primary recovery aid. The beacon is actuated when the capsule separates from the second-stage motor. The SARAH folding antenna is modified by the addition of a mounting bracket which positions the extended antenna so that its major axis coincides with the longitudinal axis of the transmitter. The folded antenna is retained by a loop of water-soluble polyvinyl acetate. After water entry, the loop is dissolved, releasing the antenna. During laboratory tests, the SARAH beacon was subjected to 401g acceleration for 0.002 second with no resulting damage or degradation in performance.

Dye Markers: For each dye marker, (see figure 14) a mixture of 20 parts of fluorescent dye and 1 part of glycol wax is pressed into a 1-inch-diameter cylinder. The resultant marker, when exposed to sea water on one end only, has a dissolution rate of 1/4 inch per hour. Two cylinders, each 1.5 inches long, are encased in a jacket of polyurethane foam (for its flotation properties) and are installed in cavities on top of the capsule's contents. Three cylinders, each 1 inch long, are cemented to the underside of the capsule lid (drag plate). To provide a high-intensity, short-duration marker, a standard "Mae-West" marker package is tied to the capsule. Immediately after water entry, this package exposes a large marker, which lasts for approximately 45 minutes.

Radar Chaff: Two types of chaff are utilized in the capsule to provide an indication of successful operation and to assist in the location of the capsule:

1. C-band chaff is packaged in the transition piece as shown in figure 8. Acquisition of C-band chaff by tracking radar indicates that the capsule has separated from the second-stage motor and shows its approximate separation altitude.
2. S-band chaff is packaged in the capsule. Acquisition of the S-band chaff indicates that the lid of the capsule has been ejected. In addition, because ejection occurs at 20,000-foot altitude during the descent, acquisition of S-band chaff is one means of determining the approximate impact point of the capsule.

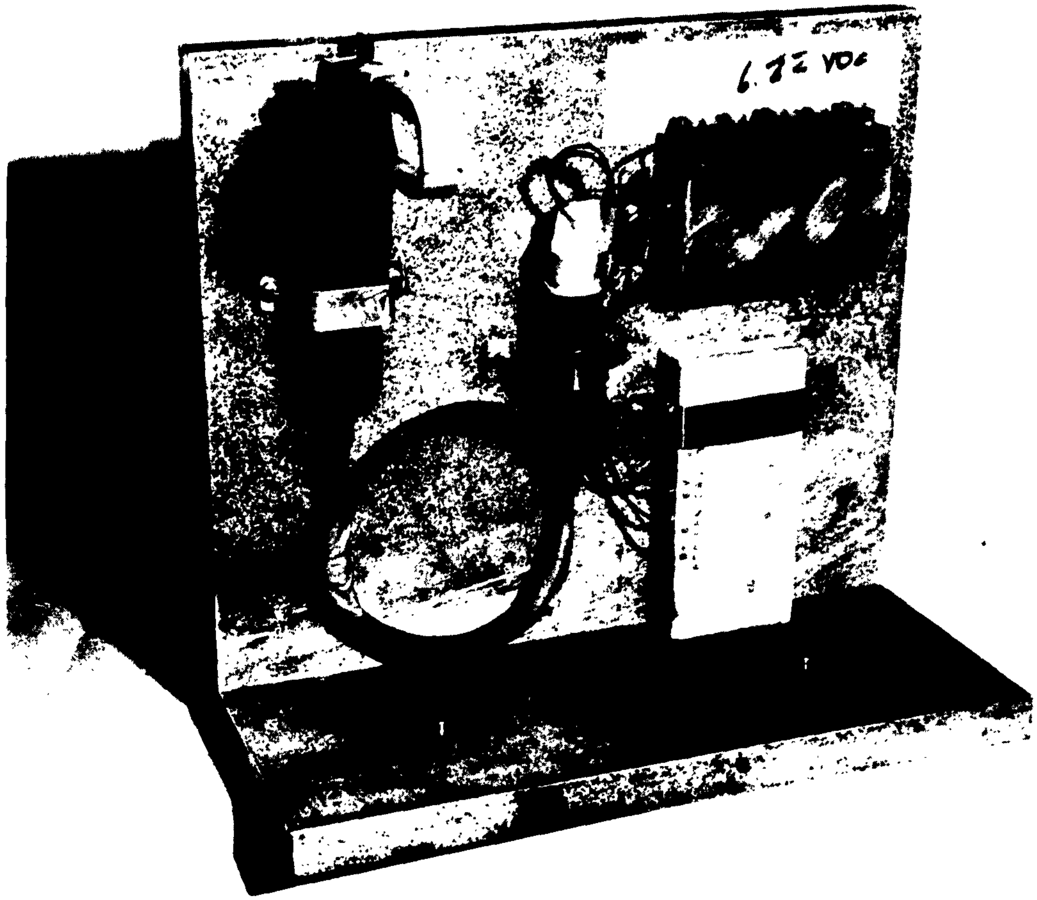


Figure 13. SARAH Beacon Mounted for Drop Tests.

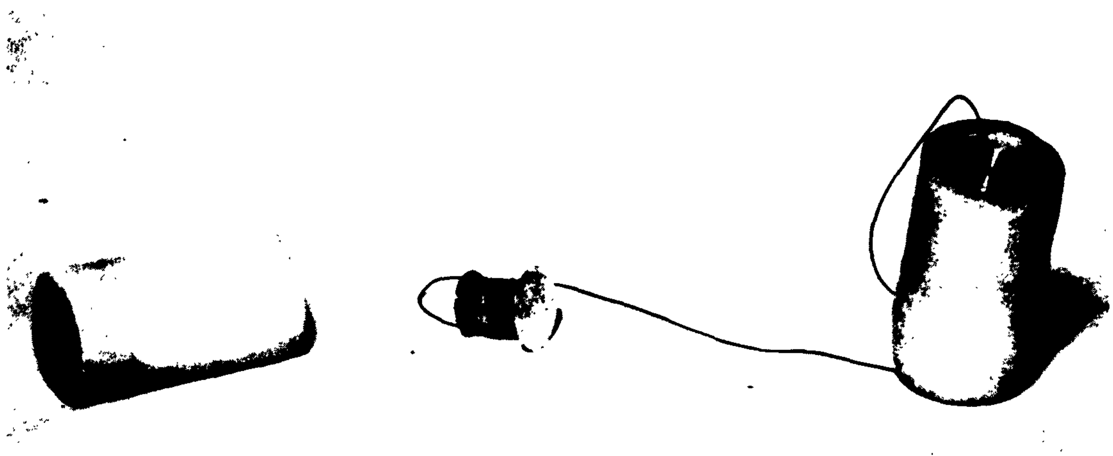


Figure 14. Dye Marker.

Payload

Objectives

The purpose of the rear-looking camera is to provide information on the performance of the vehicle and to obtain high-resolution photographs of the earth's surface. Analysis of the film is expected to reveal capsule stability throughout flight, the maximum altitude attained, and the approximate trajectory described.

Description

The payload consists of a P2 70mm aerial camera (see figure 15) mounted in the capsule with its field of view in the aft direction and the optical axis of the camera lens at an angle of 30 degrees with the longitudinal axis of the capsule. The mounting angle provides additional field of view due to the residual spin of the capsule during flight. Of the two payloads constructed, one camera was equipped with a 3-inch focal length lens and the other with a 6-inch focal length lens. Both cameras were equipped with standard, 15-foot magazines loaded with Eastman Kodak SO-213 film, a fine-grain panchromatic with haze-penetration qualities for aerial photography.

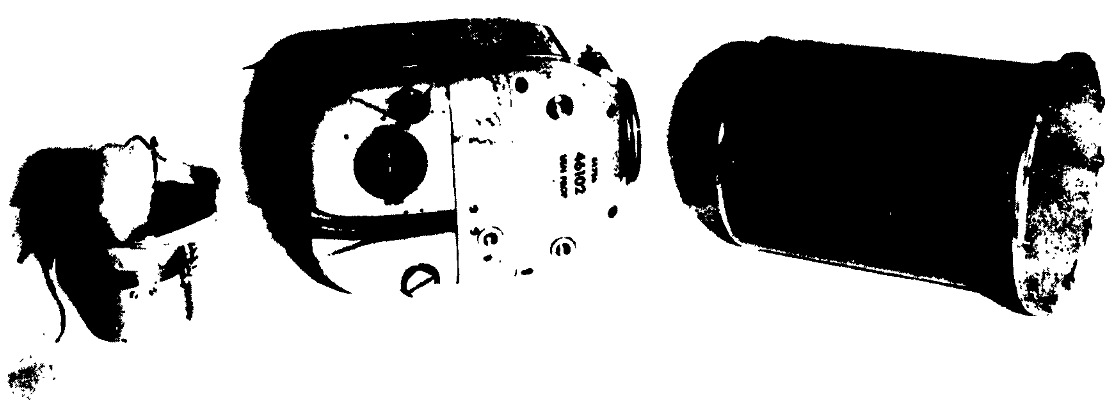


Figure 15. Payload for RSP.

Resolution

At an altitude of 145,000 feet, use of the 3-inch lens will provide coverage of approximately 17.7 x 10^9 square feet (about 634 square miles) with a resolution of about 24.6 feet. At this same altitude, use of the 6-inch lens will provide coverage of approximately 4.4×10^9 square feet with a resolution of about 12.3 feet.

Camera Timer

To provide photo coverage during that portion of the flight in which the camera is pointed towards the earth, a timer is adapted to the camera to expose 4 frames of film every 5 seconds. The frame rate is 8 frames per second. The camera mechanism required modification prior to attachment of the timer, because in normal operation the camera exposes 10 frames each time it is triggered with an electrical pulse. The completed camera modification provides camera coverage from capsule separation to a point following apogee.

Electrical Circuit

Capsule

The RSP capsule contains two independent electrical circuits, as shown in figure 16, one connecting the 6-volt power supply to the recovery beacon and the other connecting the 28-volt power supply to the camera and pyrotechnics. Each circuit has a checkout and arming plug, to allow battery charging and preflight checkout. The arming plug of the 6-volt circuit is potted with a watertight sealing compound 5 hours prior to flight time, and the 28-volt arming plug is installed during the final assembly. Both circuits are activated by the action of payload separation.

Transition Piece

The transition piece houses the electrical circuit which actuates the payload-separation device. Variations in the circuitry and separation method between capsules 1 and 2 are described below:

Capsule No. 1: The transition piece contains the primary separation circuit shown in figure 17. This circuit utilizes the closing of the second-stage ignition switches to actuate two 15-second, pyrotechnic, time-delay switches, made by the Atlas Powder Company. At 35 seconds after launch, the second bank of switches actuates the payload-separation system.

Capsule No. 2: In capsule No. 2, the primary separation circuit actuates two 18-second, pyrotechnic, time-delay switches, made by Ordnance Associates and the secondary separation circuit shown in figure 17 is added. This second circuit, which is completely independent of the primary one, actuates two 43-second time-delay switches, made by Ordnance Associates, just as the missile leaves the aircraft. The secondary circuit is also independent of the second-stage ignition system. The primary circuit is set to operate at t = 38 seconds, and the secondary circuit at t = 43 seconds. Each system has a separate arming

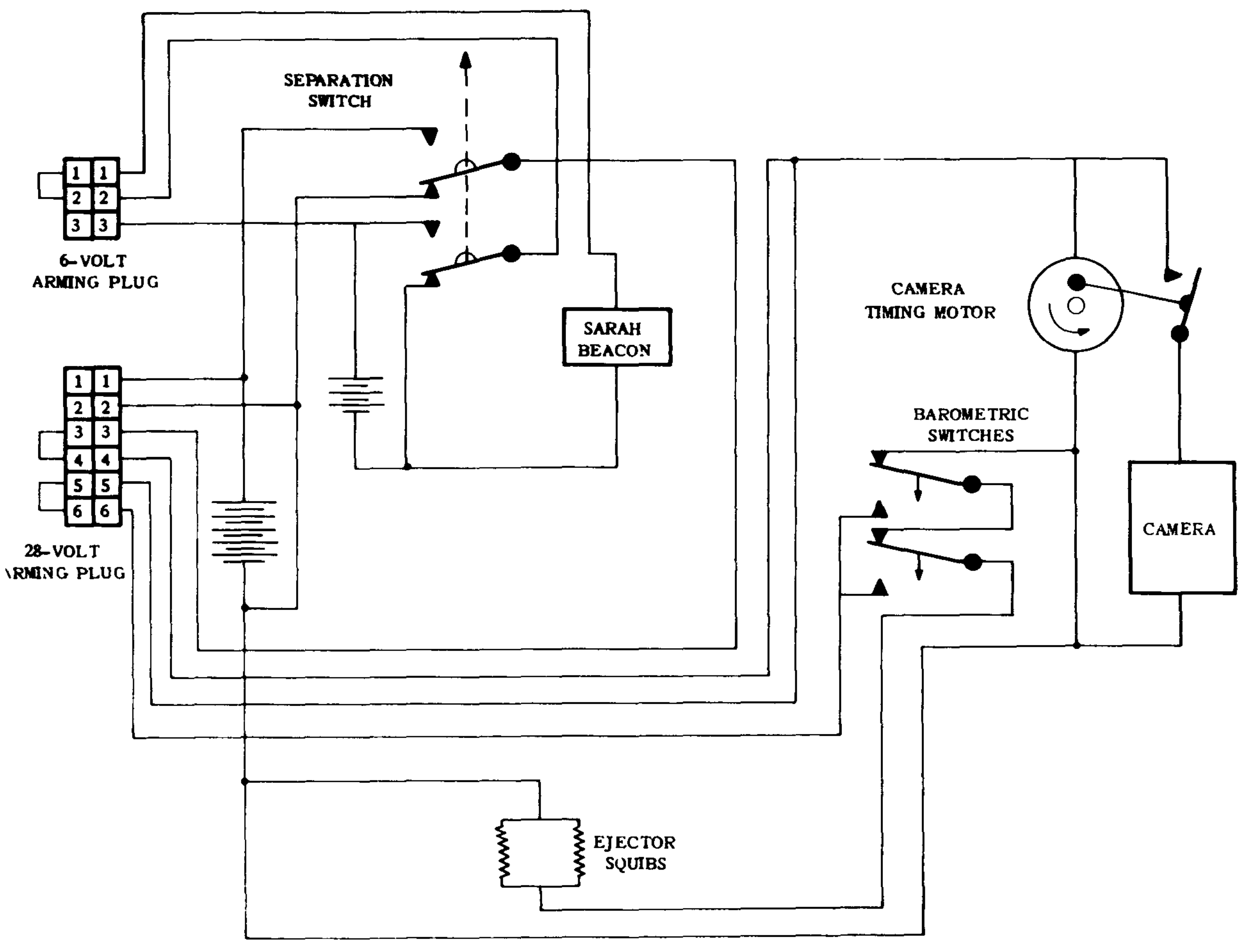
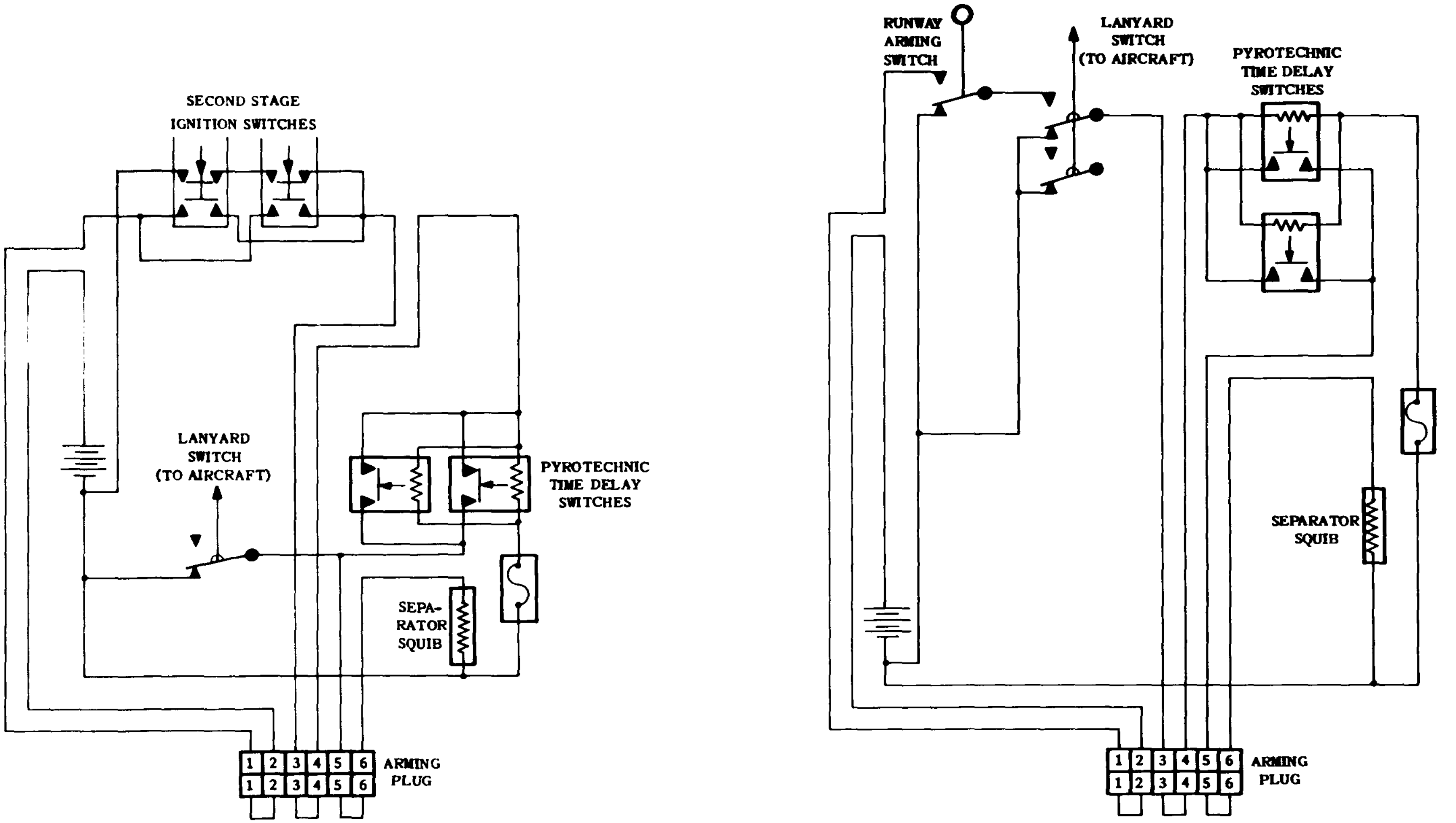


Figure 16. RSP Capsule Circuit.



PRIMARY SEPARATION CIRCUIT

SECONDARY SEPARATION CIRCUIT

Figure 17. RSP Payload Separation Circuits.

plug, and each circuit is connected to only one of the separator squibs. The remaining squib is fired sympathetically. After completion of the wiring and checkout, the transition piece is potted in polyurethane foam to protect the wiring from in-flight vibrations.

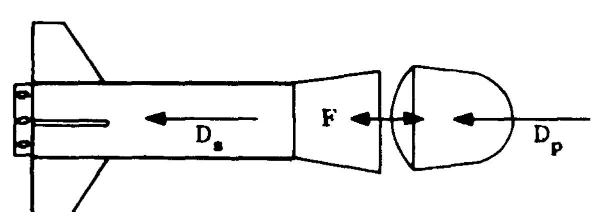
Weights

Components		Weight (Lbs)
Capsule (empty)		5.6
Drag plate		0.7
Batteries (total)		
28-volt		3.0
6-volt		1.8
Barometric switches (2)		0.165
Camera		5.6
Camera Timer		0.5
Ejector		0.75
Dye		1.0
Chaff		1.0
SARAH beacon		0.85
Heat shield		6.0
Miscellany		4.0
	Total weight	30.965

TEST PROGRAM AND ANALYSIS

Separation Analysis

At the time of separation, the payload and spent second stage are flying a trimmed-ballistic flight path in the atmosphere; therefore, the negative acceleration resultant from drag is an important consideration in designing a separation system. The total acceleration between the payload capsule and second stage can be found by the following equation:



$$A = \frac{D_s + F}{M_s} + \frac{F - D_p}{M_p}$$

Where:

A	=	Acceleration of the payload relative to the spent second stage	Ft/Sec^2
D_s	=	Drag acting on the spent second stage	Lbs.
D_p	=	Drag acting on the payload	Lbs.
M_s	=	Mass of the spent second stage	Slugs
M_p	=	Mass of the payload	Slugs
F	=	Force applied by the separator	Lbs.

In applying this equation two considerations appear. First, since the vehicle is both increasing in altitude and decelerating, the magnitude of the drag loads is decreasing with time. Second, since the mass of the second stage is almost two and one half times that of the payload (2.39 slugs compared to 0.98 slug) its drag must be greater by the same proportion in order to assure that the payload will separate without being overtaken and damaged.

The payload capsule is a high-drag configuration, and, during flight, it masks the frontal area of the second-stage motor. As the payload and the spent second stage move apart the drag of both increase, the payload because of the decrease in the boattail effect provided by the second stage, and the motor case because it then presents an open scoop to the airstream. There is no convenient method of measuring or calculating the drag transients during separation, but calculations do show that when the motor case is exposed to unobstructed airflow, its drag will be great enough to cause positive separation.

For the purposes of design, the drag coefficient of the payload is taken as the free-stream value, while the drag coefficient of the second-stage motor is taken as that which existed before capsule separation. Using the relative acceleration depicted in figure 18, the minimum positive separation distance can be calculated for any initial separation velocity and time after launch.

Ground Tests

Separator

Capsule No. 1: The separation system of capsule No. 1 utilizes a spring with a spring constant of 640 pounds per inch and a 1-inch stroke. The spring is held restrained by an NMC-developed explosive bolt, charged with two DuPoint D57 time-delay blasting caps. The charge is fired 35 seconds after launch by a 6-volt mercury battery. This combination is theoretically capable of providing a minimum positive separation of 18.4 inches.

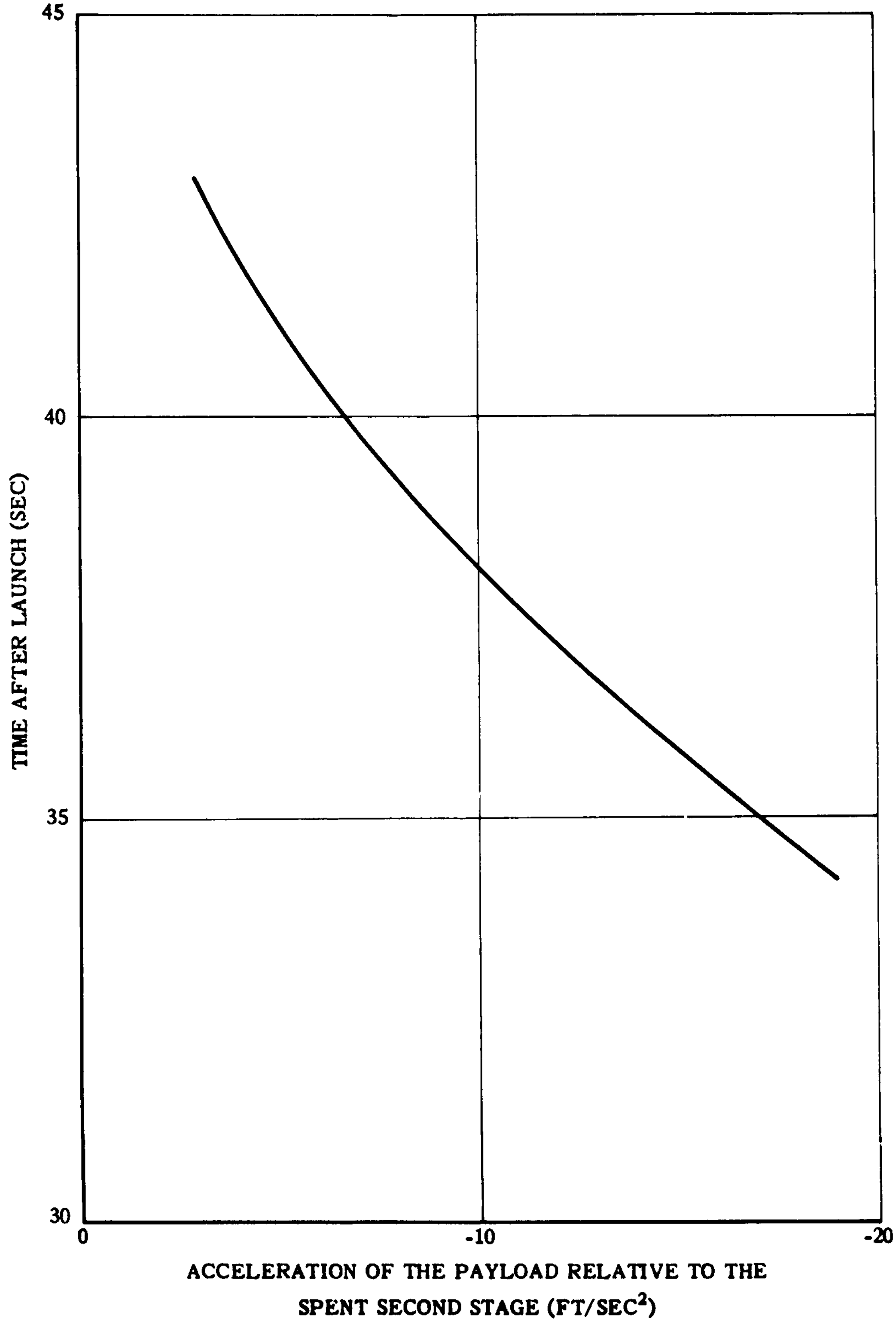


Figure 18. Relative Accelerations at Time of Separation.

Eight functional tests were performed on the explosive bolt during its development. The first five configurations proposed were tested and three additional tests were made of the selected configuration to assure that a clean fracture was obtained. The selected configuration was subjected to a static tensile load of 6,500 pounds with no permanent deformation resulting.

Capsule No. 2: An NMC-developed explosive actuator is used to separate RSP capsule No. 2 from the second-stage booster. During its development, the actuator was fired six times with a weighted dummy payload (see table 2) and the initial velocity and mechanical performance noted. The first three of these ground tests were primarily concerned with charge selection and battery-pack performance; the last three were used to determine the performance of the selected charge (two 4-grain DuPont S-68 squibs).

Table 2. Tests of RSP Piston Separator

Test No.	Charge			Initial Velocity (Ft/Sec)	Conditions
	Grains, Each	Number Used	Type		
1	1.5	2	S-75	7.3	Fired at ambient temperature and pressure.
2	2	2	S-68	9.8	Fired at ambient temperature and pressure.
3	2	2	S-68	10.1	Fired with NiCad power pack after soaking for 30 minutes at -57°F.
4	4	2	S-68	12.7	Fired with live ejector squibs installed. The ejector operated successfully after the test.
5	4	2	S-68	13.9	Fired with NiCad power pack after being chilled with CO_2.
6	4	2	S-68	Not Measured	Fired with NiCad power pack after soaking for 30 minutes at -55°F, with time delay circuit. Only one squib was connected, the other fired sympathetically.

The actuator's electrical circuit provides two separate firing systems, the first timed to actuate 38 seconds after launch and the second 43 seconds after launch. The ground tests were performed with a 31-pound capsule and a rigidly mounted dummy second stage. Assuming the separation velocity to be the same in flight as in the ground tests the minimum positive separation distance will be

8 feet if seprated at 38 seconds after launch and 26.9 feet if separated at 43 seconds after launch.

The internal ballistics of an actuator of this type vary considerably as a function of the ejected weight, it is therefore noted that since the effective ejected weights are in fact the drag loads, the ground tests performed do not give an accurate indication of the actuators performance in flight. But, since the effective ejected weight is to be less in flight, e.g. the initial velocity higher, no attempt was made to determine the magnitude of the increase in separation distance.

Ejector

The device used to eject the capsule's rear lid and deploy it as a drag plate is shown in figure 13. It consists of a squib-operated piston of 3/4-inch bore and 1-inch stroke, to which the rear lid is attached with an adjustable collar. The piston also serves as the main structural spar between the transition piece and the capsule. It is attached to the capsule structure by a 3/16-inch aluminum shear pin.

During its development, the ejector was operated with a number of squib combinations. For each charge, the initial velocity of the drag plate and the mechanical performance of the ejector were noted. The charge selected, two DuPont S-75, 1-grain squibs, imparts an initial velocity of 34 feet per second to the 1.33-pound drag plate. This velocity provides a positive separation which assures that the drag plate is free of the capsule flow field and that the 15-foot nylon riser is fully extended. Six tests were conducted using this charge. These are listed in table 3.

Environmental Tests

Procedure

To determine and test for the shock at water impact, the following test program was conducted. (For detailed information, see reference 3.)

1. Impact accelerations were calculated for a range of terminal velocities to determine the duration of the accelerations.
2. A dummy capsule, including the drag plate, was dropped at various altitudes from a helicopter to determine the maximum acceleration at water entry, and to evaluate the effectiveness of the drag plate. The maximum applied acceleration was measured with an impact gage located at the inside wall of the capsule.

Table 3. Tests of the Rear Lid Ejector of the RSP Capsule
(Two Dupont S-75, 1-Grain Squibs Used as Charge)

Test No.	Ejected Weight (Lbs)	Initial Velocity (Ft/Sec)	Description of Test
1	1.33	34	Fired vertically at ambient temperature and pressure.
2	1.33	36	Fired vertically at ambient temperature and pressure.
3	1.3	NA	Fired from dummy capsule during free fall.
4	1.35	33	Fired vertically at ambient temperature and pressure.
5	NA	NA	Fired horizontally after chilling with CO_2.
6	1.36	34	Fired from dummy capsule following a capsule separation test.

3. The acceleration amplitudes and duration data obtained in 1 and 2 above, were used as initial conditions in tests to determine the reduction in accelerations resulting from the polyurethane-foam packaging material surrounding the radio beacon. The radio beacon and its components were then subjected to the attenuated values of acceleration plus an appropriate safety factor.

Helicopter Drop Tests

1. Results of the flight tests are shown in table 1. It should be noted that the maximum acceleration at water impact is dependent upon nose radius; therefore, results shown are valid only for the high-drag configuration of the RSP capsule.
2. The drag plate was demonstrated to be an effective deceleration device. The addition of the stabilizing nylon cone on the riser decreased the total drag but greatly increased the stability. Terminal velocity was reduced from 360 feet per second to approximately 160 feet per second.

Laboratory Tests

Reduction in Impact Acceleration Due to Packaging: Because of the relatively high velocities attained by RSP capsules and the resultant water-impact shock imposed on the payload, tests were conducted in the NMC Environmental Laboratory, to determine the characteristics and effects of that shock (reference 3). A fiberglass mockup of the RSP capsule was fitted with a dummy payload fabricated to simulate the weight, center of gravity, and area of the actual payload. The dummy payload was potted in the capsule with polyurethane foam which supported it 1/2 inch above the interior surface of the capsule's nose. The acceleration values obtained from the flight test were reproduced with the laboratory drop-tester and the acceleration of the dummy payload measured (see figure 19).

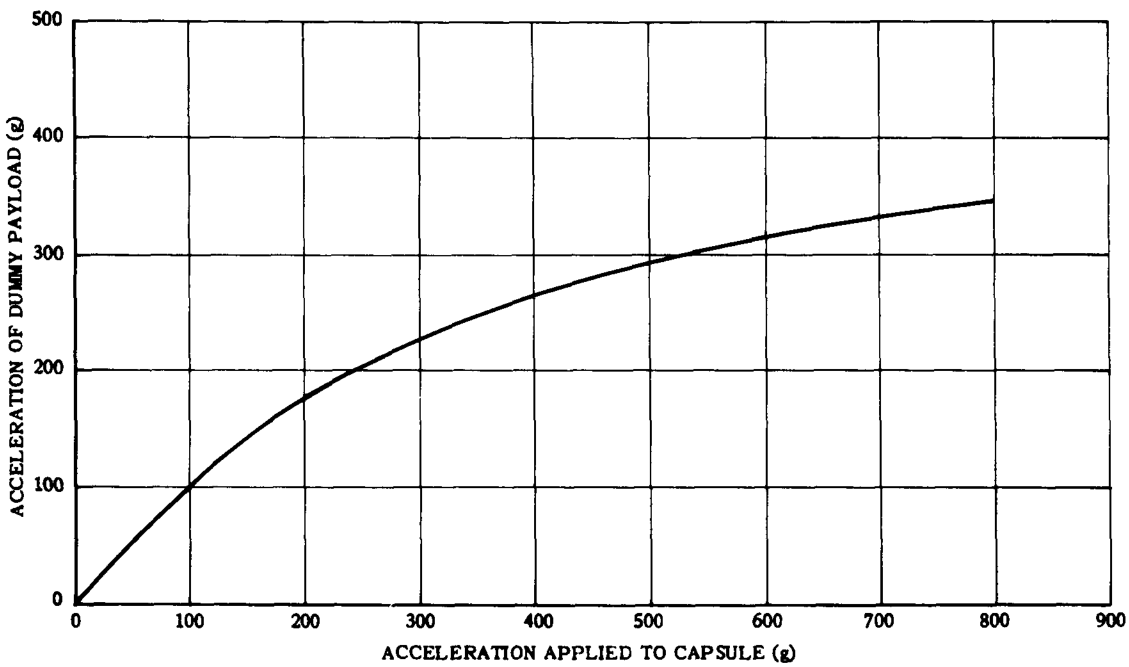


Figure 19. Results of Laboratory Tests of the Payload Packaging System.

Tests on Radio Beacon: The only critical component in the RSP recovery capsule that must operate after water impact is the SARAH radio beacon. This beacon utilizes a vacuum tube which is operating at the time of impact. In order to assure that the beacon would operate after impact, the components were mounted on a test bracket in the proper orientation (see figure 14) and subjected to two tests on the drop-tester. These tests were at levels of 115 and 150 per cent of the expected shock at water impact. Before each test, the beacon was allowed to operate for a period of 5 minutes to achieve operating temperature. Before and after the drop tests, the transmitting frequency and field intensity were measured to assure that there had been no permanent damage. No malfunctions, intermittencies, or shifts in output were noted during this test series.

PERFORMANCE

Flight Test No. 1

The RSP vehicle No. 1 was air launched over the Pacific Missile Range on 30 June 1961. The first- and second-stage motors fired satisfactorily and both stages were aerodynamically stable. The capsule failed to separate from the second-stage motor as indicated by the absence of C-band chaff.

Flight Test No. 2

The RSP vehicle No. 2 was air launched over the Pacific Missile Range on 5 September 1961. Following are the details of the flight test:

Range Support Utilized

Equipment	Mission
WV aircraft	Electronic and visual search
S2F aircraft	Visual search
Helicopter	Visual search
USNS RANGE RECOVERER	Electronic and visual search
AN/FPS-16 radar	C-band chaff acquisition
SCR-584 radar	S-band chaff acquisition
DREXEL boat	Visual search

Sequence of Events

t = 0	Launch
t = 8 min	C-band chaff acquired at 115,000-foot altitude, 1.6 miles north of launch point
t = 15 min	S-band chaff acquired at 28,000-foot altitude, 11.5 miles north of launch point
t = 45 min	Dye marker sighted by WV aircraft 13 miles north of launch point
t = 50 min	Drag plate retrieved by helicopter

Results

The capsule impacted within 2 miles of a fishing boat and was retrieved on board at approximately t = 15 minutes. The drag plate and the dye markers were severed and subsequently recovered by the helicopter. The capsule was needlessly disassembled by the fishing boat's crew, but the following information was obtained through interrogation of the crew, following the operation.

a. Capsule location--The impact point of the capsule was in the area indicated by the S-band chaff.

b. Heat shield--Slight ablation occurred at the nose back to a point approximately 6 inches from the stagnation point, indicating that the maximum temperature during flight was in excess of 500 degrees F. There was no pitting or concentrated erosion of the heat shield and the capsule shell was not dented or otherwise damaged.

c. Recovery aids--The dye markers were attached and working properly following water impact. No signal was received from the radio beacon during the operation but there was evidence to indicate that it was operating prior to disassembly of the capsule.

d. Payload--Nine of the 15 feet of film had been exposed during flight but was ruined during subsequent handling on board the fishing boat.

CONCLUSIONS

Test results indicate that the RSP or CARP capsule configuration was aerodynamically stable during flight.

The aft lid of a high drag capsule can be used as a simple and effective deceleration device.

Filling the interior of a recoverable capsule with polyurethane foam is an effective means of assuring buoyancy and protecting the payload from shock at water impact.

The combination of radar chaff and sea marker dye can provide location of a recoverable capsule that has a relatively small impact area.

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